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L3	L2 and (pulse and (time adj intervals))	42	L3
L2	(control$4 adj motion) and (processor adj5 memory)	400	L2
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L4	L2 and (stepper adj motor)	45	L4
L3	L2 and (pulse and (time adj intervals))	42	L3
L2	(control$4 adj motion) and (processor adj5 memory)	400	L2
L1	(control$4 adj motion) and (processor adj5 memory) and (pluses adj5 (time adj intervals))	0	L1

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L4: Entry 37 of 45 File: USPT Apr 30, 1996

DOCUMENT-IDENTIFIER: US 5513096 A
TITLE: Multi-axis motion controller and lid dispenser

Abstract Text (1):
A multi-axis motion controller includes a digital signal processor operable in a standalone mode to run a motion control application program for controlling motion along multiple axes is organized in a shared memory architecture and includes a serial I/O data system with DMA access to the memory for repeatedly moving input and output data directly between the memory and a serial data line. The motion controller may be utilized in connection with a cup lid dispenser for an automated drinkmaker having a pivotable shuttle arrangement for dispensing the bottommost lid in a stack, and a double lid sensor for determining if more than one lid has been dispensed.

Brief Summary Text (3):
This invention relates to motion controllers used to control multiple step motors and/or servos in coordinated multi-axis motion. The invention particularly relates to motion controllers with digital signal processors in standalone and multiprocessor implementations which use serial input and output for at least some controlled functions. The present invention also relates to a lid dispensing and application arrangement which may be controlled by the motion controller of the present invention.

Brief Summary Text (8):
To provide the motor control, the motion controller must often perform intensive signal processing calculations. To provide multiple motor control, these calculations may tax the capabilities of the processor performing them, even where the processor is a digital signal processor (DSP), which is optimized for such tasks. To provide the I/O functions, data handling, memory accessing and other more generalized computer functions are used.

Brief Summary Text (19):
In accordance with the teachings herein, the present invention provides a multi-axis motion controller comprising a digital signal processor operable in a standalone mode to run a motion control application program for controlling motion along multiple axes. The digital signal processor has shared read and write access to a digital memory organized in a shared memory architecture. The memory may be shared by at least one other device. A first portion of the shared digital memory stores input data received from input devices and a second portion of the memory stores output data to be send to output devices. A serial input/output system (SIO) includes a serial data line for serially transferring the input and output data to and from input and output devices, and DMA access means which repeatedly moves the input and output data directly between the memory and the serial data line, without passing the data through the digital signal processor. The DMA access means has shared read and write access to the digital memory. In one embodiment, the memory can also be shared by other coprocessors.

Detailed Description Text (4):

The DSP engine 10 includes a digital signal processor 32 and shared memory comprising non-volatile memory E2ROM 34 and static RAM 36. In one embodiment of the invention there is up to 64K of E2ROM and 64K of static RAM.

Detailed Description Text (5):
A local bus comprising address lines 38, data lines 40 and various control lines connect the digital signal processor 32 with the shared memory 34, 36. The local bus is connected to the external bus via bi-directional buffer 42, so that the data may be moved along the local bus independent of data on the external bus 12.

Detailed Description Text (7):
The digital signal processor 32 on the DSP engine 10 is operable in a standalone mode to run a motion control application program for controlling motion along multiple axes. In many applications, only the DSP engine will be used and the DSP coprocessor 22 and DOS engine 24 will not be connected to the external bus. In these applications the external bus interface on PGA 50 will not be required. Accordingly, external bus control will be asserted directly by PGA 48 over control lines 46.

Detailed Description Text (13):
Digital signal processors are particularly efficient at performing calculations needed to control motion, and are less efficient at handling data--which is the province of generalized computer microprocessors such as the processor which would be located on optional DOS engine coprocessor board 24.

Detailed Description Text (62):
Referring to the drawing FIGS. 5-11b in detail, there is shown and described preferred embodiments of a lid dispenser 200, the operation of which may be controlled by the motion controller hardware and software described above. In particular, the lid dispenser may be constructed and operated as part of an integrated automated drinkmaker as shown and described in U.S. Pat. Nos. 4,949,526, 4,989,753, and 5,000,345, the disclosures of which are hereby incorporated by reference. The automated drinkmaker may comprise a cup carousel, a cup dispenser station, an ice dispenser station, and a soda dispensing station, in addition to the lidder assembly as described herein.

Detailed Description Text (64):
The lid dispenser 200 uses a linear motion, as illustrated in FIGS. 5-10, to pull a lid 201b (to the left as shown in FIGS. 5a and b and 6a and b) from the bottom of a stack and load it into a lid applicator 202. The lid applicator 202 moves in a straight, horizontal line over cup 204 as it applies lid 201 thereto. At the start of the lid application procedure, lid 201 catches on the front edge of the cup, FIG. 6a. As the applicator is drawn rearwardly (to the right as shown FIG. 6b), the lid is pulled out of the applicator and is applied by a lid presser 203 onto the cup. The lid presser 203 maintains a steady downward pressure on lid 201 as it is being drawn out of the applicator, causing the lid to snap onto cup 204. A cup platform elevator 250 supports the cup and is moveable up or down by a stepper motor directed by the controller to adjust the top of the cup 204 to the proper height for lid application. The lid applicator 202 is preferably constructed of a high yield strength alloy which is designed to apply a relatively constant predetermined force downwardly upon the lid regardless of the magnitude of the deflection of the lid applicator, within normal operating conditions. It should be recognized that cups are delivered within a given tolerance range as to their height which will cause more or less deflection of the lid applicator.

Detailed Description Text (76):
The lid applicator may also included an inductive sensor on the lidder drive. A number of driving pulses are issued to the lid shuttle drive motor, and the processor then checks for a signal from the inductive sensor at the proper time. If one is not received, a lid is assumed to be jammed against the cup, and the

elevator is dropped a small distance of approximately a quarter inch. A drive signal is then issued again to the stepper motor, and the processor then checks again for the transition signal from the inductive sensor, indicating successful lidding. If the transition signal is not received, the processor assumes a more serious problem, and an error message is displayed on a display to the operator, requesting a check of the elevator lidder station, and pressing of a service completed button after the check indicates that the elevator lidder station is clear.

CLAIMS:

1. A multi-axis motion controller comprising:

a digital signal processor operable in a standalone mode to run a motion control application program for controlling motion along multiple axes;

a digital memory organized in a shared memory architecture for shared read and write access by the digital signal processor and at least one other device, including a first portion of the memory for storing input data received from input devices and a second portion of the memory for storing output data to be sent to output devices; and

a serial input/output system including:

a serial data line for serially transferring the input and output data to and from input and output devices;

DMA access means for repeatedly moving the input and output data directly between the memory and the serial data line without passing the input and output data through the digital signal processor, the DMA access means having shared read and write access to the digital memory.

8. A multi-axis motion controller according to claim 6 further including a second processor connected to the digital signal processor via a multiprocessor bus, the digital signal processor running in a master mode and the second processor running in a slave mode, and wherein the digital memory is shared by the digital signal processor and the second processor.